However, even if GHG emissions had stabilized at 2000 levels, the global climate system would already be committed to a warming trend of about 0.1 degree C per decade over the next two decades, in the absence of large changes in volcanic or solar forcing. Meehl et al. (2006) conducted climate change scenario simulations using the Community Climate System Model, version 3 (CCSM3, National Center for Atmospheric Research), with all GHG emissions stabilized at 2000 levels, and found that the global climate system would already be committed to 0.40 degree C more warming by the end of the 21st century.

With respect to warming in the Arctic itself, the AR4 concludes: ''At the end of the 21st century, the projected annual warming in the Arctic is 5 degrees C, estimated by the multi-model A1B ensemble mean projection'' (see IPCC 2007, p. 908, Fig. 11.21). The across-model range for the A1B scenario varied from 2.8 to 7.8 degrees C. Larger mean warming was found for the A2 scenario (5.9 degrees C), and smaller mean warming was found for the B1 scenario (3.4 degrees C); both with proportional across-model ranges. Chapman and Walsh (2007, cited IPCC 2007, p. 904) concluded that the across-model and across-scenario variability in the projected temperatures are both considerable and of comparable amplitude.

In regard to changes in sea ice, the IPCC AR4 concludes that, under the A1B, A2, and B1 SRES emissions scenarios, large parts of the Arctic Ocean are expected to be seasonally ice free by the end of the 21st century (IPCC 2007, p. 73). Some projections using the A2 and A1B scenarios achieve a seasonally ice-free Arctic by as early as 2080–2090 (IPCC 2007, p.771, Figure 10.13a, b). Sea ice reductions are greater in summer than winter, thus it is summer sea ice cover that is projected to be lost in some models by 2080–2090, not winter sea ice cover. The reduction in sea ice cover is accelerated by positive feedbacks in the climate system, including the ice-albedo feedback (which allows open water to receive more heat from the sun during summer, the insulating effect of sea ice is reduced and the increase in ocean heat transport to the Arctic further reduces ice cover) (IPCC 2007, p. 73).

While the conclusions of the IPCC TAR and AR4 are similar with respect to the Arctic, the confidence level associated with independent reviews of AR4 is greater, owing to improvements in the models used and the greater number of models and emissions scenarios considered (J. Overland, NOAA, in litt. to the Service, 2007). Climate models still have challenges modeling some of the regional differences caused by changing decadal climate patterns (e.g., Arctic Oscillation). To help improve the models further, the evaluation of AR4 models has been on-going both for how well they represent conditions in the 20th century and how their predicted results for the 21st century compare (Parkinson et al. 2006; Zhang and Walsh 2006; Arzel et al. 2006; Stroeve et al. 2007, pp. 1–5; Holland et al. 2006, pp. 1–5; Wang et al. 2007, pp. 1,093–1,107; Chapman and Walsh 2007).

Arzel et al. (2006) and Zhang and Walsh (2006) evaluate the sea ice results from the IPCC AR4 models in more detail. Arzel et al. (2006) investigated projected changes in sea ice extent and volume simulated by 13 AOGCMs (also known as GCMs) driven by the SRES A1B emissions scenario. They found that the models projected an average relative decrease in sea ice extent of 15.4 percent in March, 61.7 percent in September, and 27.7 percent on an annual basis when comparing the periods 1981–2000 and 2081–2100; the average relative decrease in sea ice volume was 47.8 percent in March, 78.9 percent in September, and 58.8 percent on an annual basis when comparing the periods 1981–2000 and 2081–2100. More than half the models (7 of 13) reach ice-free September conditions by 2100, as reported in some previous studies (Gregory et al. 2002, Johannessen et al. 2004, both cited in Arzel et al. 2006).

Zhang and Walsh (2006) investigated changes in sea ice area simulated by 14 AOGCMs driven by the SRES A1B, A2, and B1 emissions scenarios. They found that the annual mean sea ice area during the period 2080–2100 would be decreased by 31.1 percent in the A1B scenario, 33.4 percent in the A2 scenario, and 21.6 percent in the B1 scenario relative to the observed sea ice area during the period 1979–1999. They further determined that the area of multi-year sea ice during the period 2080–2100 would be decreased by 59.7 percent in the A1B scenario, 65.0 percent in the A2 scenario, and 45.8 percent in the B1 scenario relative to the ensemble mean multi-year sea ice area during the period 1979–1999.

Dumas et al. (2006) generated projections of future landfast ice thickness and duration for nine sites in the Canadian Arctic and one site on the Labrador coast using the Canadian Centre for Climate Modelling and Analysis global climate model (CGCM2). For the Canadian Arctic sites the mean maximum ice thickness is projected to decrease by roughly 30 cm (11.8 in) from 1970–1989 to 2041–2060 and by roughly 50–55 cm (19.7–21.7 in) from 1970–1989 to 2081–2100. Further, they projected a reduction in the duration of sea ice cover of 1 and 2 months by 2041–2060 and 2081–2100, respectively, from the baseline period of 1970–1989. In addition simulated changes in freeze-up and break-up revealed a 52-day later freeze-up and 30-day earlier break-up by 2081–2100.

Holland et al. (2006, pp. 1–5) analyzed an ensemble of seven projections of Arctic summer sea ice from the Community Climate System Model, version 3 (CCSM3; National Center for Atmospheric Research, USA) utilizing the SRES A1B emissions scenario. CCSM3 is the model that performed best in simulating the actual observations for Arctic ice extent over the PM satellite era (Stroeve et al. 2007, pp. 1–5). Holland et al. (2006, pp. 1–5) found that the CCSM3 simulations compared well to actual observations for Arctic ice extent over the PM satellite era, including the rate of its recent retreat. They also found that the simulations did not project that sea ice retreat would continue at a constant rate into the future. Instead, the CCSM3 simulations indicate abrupt shifts in the ice cover, with one CCSM3 simulation showing an abrupt transition starting around 2024 with continued rapid retreat for around 5 years. Every CCSM3 run had at least one abrupt event (an abrupt event being defined as a time when a 5-year running mean exceeded three times the 2001–2005 observed retreat) in the 21st century, indicating that near ice-free Septembers could be reached within 30–50 years from now.

Holland et al. (2006, pp. 1–5) also discussed results from 15 additional models used in the IPCC AR4, and concluded that 6 of 15 other models ''exhibit abrupt September ice retreat in the A1B scenario runs.'' The length of the transition varied from 3 to 8 years among the models. Thus, in these model simulations, it was found that once the Arctic ice pack thins to a vulnerable state, natural variability can trigger an abrupt loss of the ice cover so that seasonally ice-free conditions can happen within a decade's time (J. Stroeve, in litt. to the Service, November 2007).

Finally, Holland et al. (2006, pp. 1–5) noted that the emissions scenario used in the model affected the likelihood of future abrupt transitions. In models using the SRES B1 scenario (i.e., with GHG levels increasing at a slower rate), only 3 of 15 models show abrupt declines lasting from 3 to 5 years. In models using the A2 scenario (i.e., with